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A MODERATE COURSE FOR USAF UAV DEVELOPMENT

by

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Abstract

USAF unmanned aerial vehicle (UAV) advocacy from 1980 to date has swung from an apparent disinterest in UAV systems to an aggressive acceptance of UAVs to solve mission needs. However, continued UAV programmatic setbacks indicate an appropriate UAV course for the Air Force remains to be charted.

Tactical UAV programs between 1980 and the early 1990s conspicuously lacked USAF involvement and demonstrated a sub-par evolution of UAV capabilities, technology and development. However, spurred by concern over mission loss to sister services, USAF demonstrated a mid-1990s new found interest in UAVs despite the less-than-proven performance of previous UAV systems.

USAF UAV acceptance was embodied in four UAV end states and two High Altitude Endurance (HAE) UAVs. However, continued setbacks with HAE UAV programs soon impacted USAF's ability to meet UAV end state timelines as well as USAF commitment to UAV funding. HAE UAV miscues indicate the USAF UAV course charted after its mid-1990s UAV acceptance was founded on unproven technology.

Consequently, this paper recommends a moderate USAF UAV course founded on proven technology and conservative investment. This moderate UAV course is enabled by a "wait and see" approach with the ongoing HAE UAV Advanced Concept

Technology Demonstration (ACTD). The "wait and see" approach commits minimal USAF funds to HAE UAVs pending successful HAE UAV technology demonstration.

Chapter 1

Introduction

New World Vistas Air and Space Power for the 21st Century Air Force represents a collection of revolutionary ideas identifying and suggesting new technologies and resultant applications to "guarantee the air and space superiority of the United States in the 21st century."[1] The comprehensive study was conducted in 1994 as the result of a challenge to the Air Force Scientific Advisory Board by Air Force Secretary Shiela Widnall and Air Force Chief of Staff General Ronald R. Fogelman.

The technology associated with UAVs, both lethal and non-lethal, was one area *New World Vistas* identified as being critical to the Air Force's ability to chart a future course projecting air power into the 21st century. Unfortunately, charting an acceptable UAV course for the future has proved illusive to the USAF.

The thesis of this paper is the post-Vietnam USAF has experienced two extremes in developing a course for its UAV efforts. Though initially demonstrating a "hands off" course for UAVs, USAF concern over mission loss to sister services led Air Force leadership to change its course and accept UAVs as a possible solution to Air Force needs. However, in its zeal to protect its mission areas, the Air Force embarked with UAVs in a direction inconsistent with the evolution of UAV technology. Consequently, the USAF needs a moderate UAV course founded on proven technology.

In support of this thesis, this paper first provides a chronology of DOD-wide tactical UAV development and acquisition efforts during the 1980s and early 1990s. The purpose of the chronology is twofold. First, the UAV chronology encompasses an abridgement of DOD tactical UAV programs during this timeframe and allows the reader to develop sufficient perspective of—in the authors opinion—the sub-par evolution of UAV capabilities, technology, and development. Second, the chronology depicts a conspicuous lack of USAF involvement in most of these tactical UAV programs suggesting a lack of early interest in UAVs on the part of the Air Force. While a USAF cultural bias away from UAVs certainly provides a viable theory for this early "hands off" approach, proof or disproof of this theory is left to follow-on research.

Next, despite the sub-par performance of previous UAV systems, the paper evidences a mid-1990s new found Air Force interest in UAVs. The paper suggests this USAF interest in UAVs was spurred by a concern over mission loss to other services advocating the use and further development of UAVs.

The timeline continues with four USAF UAV end states, or goals, and two new UAV systems representing the Air Force's new found interest in UAVs as well as a departure from its previous "hands off" UAV approach. The paper outlines the end states as well as describes the means to the end states, Global Hawk and Dark Star UAVs. Subsequent to this discussion, the paper evidences setbacks in Global Hawk and Dark Stars development indicating the Air Force's UAV course adjustment spurred by protection of its missions represented a course over-correction founded on less-than-proven UAV technology.

Therefore, the paper finally suggests a more moderate course for future UAV development—one based on proven UAV technology and conservative investment. The moderate USAF UAV course is enabled by a "wait and see" approach to Global Hawk and Dark Star development requiring successful UAV technology demonstration prior to further significant USAF HAE UAV investment.

Notes

[1] USAF Scientific Advisory Board. *New World Vistas Air and Space Power for the 21st Century Air Force*: *Summary Volume*, 15 December 1995, n.p.; on-line, Internet, 10 December 1997, available from http://web.fie.com/fedix/vista.html..

Chapter 2

Early UAV Development—Where's the USAF

This chapter first explores the 1980 to mid-1990s evolution of UAV acquisition organizations as well as details the development, cost, and limited operational performance of five UAV systems. The five UAV systems, Aquila, Pioneer, Hunter, Medium Range, and Predator, represent an abridgement of DOD tactical UAVs developed during the timeframe and demonstrate—in the authors opinion—an overall pattern of sub-par UAV performance. The systems are covered in considerable detail to provide a thorough assessment of UAV development and to establish an overall pattern of less-than-proven UAV technological development. Second, the chapter elaborates on the conspicuous lack of USAF involvement in most early tactical UAV programs suggesting a reluctance by the USAF to consider UAVs to meet mission needs. While a USAF cultural bias away from UAVs provides a viable theory for this early USAF "hands off" course for UAVs, proof or disproof of this theory is left to follow-on research. Ultimately, this chapter lays the foundation for a follow-on argument that the Air Force later abandoned its "hands off" UAV course and accepted UAVs despite less-than-proven UAV technological development. At the outset, to avoid confusion over UAV definitions, for the purposes of this paper a UAV is defined as a recoverable aerial vehicle—either remotely piloted or autonomously controlled.[1]

UAV Acquisition Organization

Prior to elaborating on individual UAV systems, a brief overview of the UAV acquisition organization provides the context in which the various DOD agencies interact to develop and acquire UAV systems. Aquila, Pioneer, and Medium Range UAVs represented the DODs first major UAV acquisition effort after the Vietnam war.[2] These systems, designed to operate in the tactical environment of the battlefield were initially managed by the individual services with Congress encouraging cooperation among the services in their acquisition efforts[3]. This separate service approach to funding lasted until 1987 when congress consolidated UAV funding and development within the UAV Joint Program Office (JPO) overseen by the Defense Airborne Reconnaissance Office (DARO) within the Office of the Secretary of Defense.[4]

Aquila UAV—(Army Effort)

Aquila was an Army UAV acquisition effort originally begun in 1979 and designed to provide ground commanders with real-time intelligence on enemy troop locations beyond the line-of-sight of friendly forces. Originally estimated to cost just over one half billion dollars for development and procurement of 780 air vehicles, the program was abandoned in 1987 due to schedule and technical difficulties as well as excessive program costs.[5] The technical difficulties, in all fairness to Aquila are due, at least in part, to the effects of "requirements creep" on its acquisition effort.[6] In other words, as the development of the system progressed, additional requirements were added for the system to perform. Originally designed to provide ground commanders the ability to "see over the next hill", Aquila was also saddled with the requirement of precision targeting.[7]

However, by 1987 the program had run up a $1 billion dollar bill and had been successfully able to meet mission requirements on only 7 of 105 flights.[8]

Pioneer UAV (Navy Effort)

The second major post-Vietnam UAV acquisition effort, Pioneer, was initiated by the Navy in the early 1980's. Produced jointly by American and Israeli firms, Pioneer bypassed the normal development phase of the acquisition cycle with nine systems, each with eight air vehicles, procured by the Navy for naval gunfire spotting and to provide the Marine Corps with a tactical UAV capability.[9] Original procurement costs in 1986 of 72 Pioneer air vehicles and associated ground equipment was estimated at $87.7 million dollars.[10] Technical difficulties with shipboard recovery however, led the Navy to invest an additional $50 million dollars to bring the system up to "minimum essential capability."[11] The Gulf War in 1991 soon tested Pioneer's capabilities.

Pioneer Operational Performance

Despite a less-than-stellar performance in development, during the Gulf War, the Army, Marine Corps, and Navy fully utilized Pioneer for tactical intelligence, surveillance, and reconnaissance (ISR) purposes. The US Army capitalized on information gathered by Pioneer UAVs to target Iraqi artillery as the US Army made its initial push north during the ground war.[12] The Marine Corps used imagery gathered by their UAVs to supply aviators with updated target imagery.[13] In addition, it was Pioneer UAVs that supplied Marines with the initial warning of the Iraqi probing attack into the Saudi Arabian town of Khafji.[14] Finally, the Navy, launching UAVs off its ships, used the gathered information to identify shore targets for artillery fired from its boats.[15]

Summing up the performance of Pioneer in the desert environment of the Gulf War, US Adm David E. Jeremiah, Vice Chairman of the Joint Chiefs of Staff stated in a 20 March 1991 interview, "The outcome of Operation Desert Storm might not have been as swift or decisive if U.S. and allied forces had not made use of intelligence-gathering and tactical reconnaissance platforms such as the Israeli-designed Pioneer…."[16] Though Pioneer did meet with success during the Gulf War, it is not without its limitations.

While highlighting Marine Corps UAV initiatives in 1996, Gen Charles C. Krulak, Commandant of the United States Marine Corps, wrote the following about the Pioneer system:

> Unfortunately, the Pioneer has too many limitations. First, the Pioneer does not have an automatic take-off, landing, or mission execution capability which has led to a high accident rate. Second, since the UAV telemetry is calculated at a Ground Control Station (GCS) that is incapable of integrated data dissemination, we lose the ability to pass this information quickly to the units that need it. Third, because it lacks weatherproofed avionics and has no Synthetic Aperture Radar (SAR) capability, the Pioneer is useless in bad weather.[17]

It is interesting to note Admiral Jeremiah's comments were made immediately following the end of the Gulf War (conducted in a desert environment) while General Krulak made his comments after subsequent use of the Pioneer in support of operations in the Balkans—a completely different weather environment. This same environment would prove troublesome for a follow-on tactical UAV system, Predator. Despite the limitations outlined by General Krulak, Pioneer is currently in use with the Marine Corps.[18]

Medium Range UAV (Primarily Navy Effort)

The Medium Range UAV was a joint Navy and Air Force acquisition effort with the Navy responsible for development of the air vehicle and the Air Force responsible only for development of the payload.[19] Unlike the slow moving Pioneer, Medium Range UAV would complete its ISR mission at high speed and short loiter time with the payload providing near real time video feedback. Like its predecessors, however, this program also ran into development difficulties. Payload costs first estimated at $164 million in 1993 more than doubled leading the payload program to fall behind schedule.[20] In addition, air vehicle development suffered a setback when a prototype crashed. Sealing the fate of the program, the payload prototype, being tested on a surrogate air vehicle, proved too large to fit in the Navy developed air vehicle. DOD cancelled the program in October 1993 due to cost overruns.[21]

Hunter UAV (JPO—Primarily Army Effort)

Hunter, the first tactical UAV acquisition effort undertaken by the JPO, was originally designed to operate in the 200 kilometer range conducting day and night ISR and target acquisition missions for the Army providing near real time video feedback.[22] Begun in 1988, the program was estimated to cost $1.2 billion for 400 Hunter air vehicles and other required operating equipment.[23] By 1995 however, the expected cost would nearly double. Though the system demonstrated difficulties in relaying images through a second airborne vehicle (required due to range driven line-of-sight limitations), DOD awarded a contract for low rate initial production (LRIP) of seven systems, consisting of eight air vehicles each, in 1993.[24] Upon delivery however, deficiencies in software, data link, and engines were revealed.[25] Finally, several crashes in rapid succession led DOD

to allow the program to terminate by contract expiration in early 1996.[26] Subsequently, the Army retained one system for limited testing and development and put the rest of the already produced models into storage. Performance of Hunter during advanced war fighting experiments in 1997 rejuvenated some support for the system, but as of yet most of the systems remain mothballed.[27] Building on the consolidation of acquisition efforts into one office, the JPO, DOD continued work to improve the acquisition and development of UAVs as well as other "high tech" systems through implementation of the Advanced Concept Technology Demonstration (ACTD) process.

ACTD Process

The ACTD process was spawned in an effort to streamline the acquisition and development of systems throughout DOD.[28] With an ACTD, a small number of systems are acquired outside the normal acquisition channels for testing and development by operators.[29] This testing and development phase may include operational use of the system to verify performance capabilities.[30] The ACTD process is advantageous to the acquisition and development effort for at least two reasons. First, operators with firsthand knowledge of system requirements are in on the testing and development of a system in it's infancy.[31] Second, the ACTD process allows DOD to procure a system for testing while "doing away with much of the paperwork and oversight normally associated with the acquisition process."[32]

Predator UAV (JPO—Primarily Air Force Effort)

Predator, was the first JPO UAV system to have its development completed during an ACTD.[33] Predator was also the first tactical UAV with significant participation

on the part of the Air Force—albeit well into Predator's development. With a range of up to 500 miles, and endurance capabilities exceeding 20 hours, Predator was designed with the capability to provide near real time imagery intelligence to the theater CINC through use of infrared sensors along with payloads capable of penetrating adverse weather.[34] Each Predator system consists of four air vehicles along with associated ground support equipment. The Predator is flown by Air Force pilots from a remote facility with the air vehicle controlled by line-of-sight satellite relay data links. As part of its 30 month ACTD process, during 1995 and 1996, Predator was flown in Albania in support of relief operations as well as follow-on operations in Bosnia supporting Operation Deny Flight.[35]

Predator Operational Performance

Overall, Predators performance through operations in Albania, Haiti, and Bosnia have met with mixed results. In Bosnia, Predator provided humanitarian assistance monitoring, NATO troop protection, target location, search and rescue, before-and-after strike surveillance, peace accord monitoring, and general peacekeeping.[36] In 1996, General Ronald R. Fogelman, Air Force Chief of Staff, admitted some "growing pains" with Predators use in Bosnia but overall seemed pleased with its performance.[37] Perhaps the "growing pains" Fogelman referred to were related to Predator's performance in poor weather environments—specifically conditions ripe for producing ice on the air vehicles wings.[38] In testimony before Congress in April 1997, Louis J. Rodrigues confirmed Predator's weather woes as follows: "Experience with Predator deployment (to Bosnia) showed that the system can be adversely affected by unfavorable weather conditions."[39] In defense of Predator, however, some may have misconstrued Predator's early deployments to Albania and Bosnia, and subsequent weather problems, as an operational

capability when in fact the system was still in ACTD.[40] As the proponents of the ACTD process intended, one might expect a "learning curve" during a technology demonstration phase.

For better or for worse, in 1996 the Air Force assumed operational control of the remaining ACTD assets and Predator transitioned to LRIP with 20 systems in mind for a total of 80 air vehicles (four air vehicles per system).[41] This number was subsequently cut back to 12 systems, with the total number of air vehicles yet to be determined.[42] Supporting and flying the Predator through the ACTD and still today is the 11th Reconnaissance Squadron, the first Air Force operational UAV Squadron, activated in July of 1995 at Indian Springs Auxiliary Field, Nevada.[43]

USAF "Hands Off" UAV Course

As early tactical UAV programs struggled, Air Force involvement in the development of these programs was conspicuously lacking. Of the five UAV systems just outlined—representing an abridgement of DOD tactical UAV efforts from 1980 to early 1990—only Predator had significant USAF involvement in its testing and development. In fact, of seven DOD UAV programs—representing all DOD UAV efforts during this timeframe—still only Predator had significant USAF involvement in its development.[44] In the authors opinion, lack of significant involvement in UAV development prior to the mid-1990s indicates a lack of early USAF interest in UAVs. General Ronald R. Fogelman, USAF Chief of Staff, admitted as much in 1996. He wrote "in the past the Air Force had reservations about UAVs – some technical, some bureaucratic, and some cultural."[45] Echoing Fogelman's assessment of minimal early USAF UAV interest during the 1980s to mid-1990s, an *Unmanned Systems* article related

that prior to the mid-1990s "the Air Force had been perceived as reluctant to embrace the use of UAVs."[46]

In short, though Pioneer and Predator did demonstrate the capability to perform the ISR mission with some success, overall DOD UAV development and acquisition efforts, up to and including the Predator system (mid-1990s), seemed to demonstrate a less than perfect track record attributed primarily to technical difficulties and cost overruns. Furthermore, except for Predator, USAF involvement in early UAV development was minimal indicating a USAF "hands off" course for UAVs—a fact admitted by senior Air Force leadership. However, during Predator's ACTD, the Air Force began to demonstrate a new found interest in UAVs—despite the sub-par UAV performance demonstrated by previous UAV systems. The next chapter takes a closer look at USAF's new found interest in UAVs.

Notes

[1] Maj Steve Hargis, student, Air Command and Staff College, formerly with UAV Special Projects Office, interviewed by author, 10 February 1998.

[2] House, Unmanned Aerial Vehicles– DODs Acquisition Efforts: Testimony of Mr Louis J Rodrigues, Director, Defense Acquisition Issues, National Security and International Affairs Division before Subcommittee on Research and Development and Military Procurement of the Committee on National Security, 9 April 1997, 3.

[3] Ibid.

[4] Ibid.

[5] Ibid.

[6] Hargis.

[7] House, Unmanned Aerial Vehicles– DODs Acquisition Efforts: 9 April 1997, 3.

[8] Ibid.

[9] Ibid., 4.

[10] Ibid.

[11] Ibid.

[12] Lt Col Dana A. Longino, *Role of Unmanned Aerial Vehicles in Future Armed Confllict Scenarios*, Research Report no.AU-ARI-92-12. (Maxwell AFB, AL.: Air University Press, December 1994), 10.

[13] Ibid.

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[14] Gen Charles C. Krulak, "Riding the Dragon into the 21st Century," *Unmanned Systems*, Summer 1996, 11.

[15] Longino, *Role of Unmanned Aerial Vehicles in Future Armed Confllict Scenarios,* 10.

[16] Quoted in Longino, *Role of Unmanned Aerial Vehicles in Future Armed Confllict Scenarios,* xi.

[17] Krulak, "Riding the Dragon into the 21st Century," 11.

[18] Ibid.

[19] House, Unmanned Aerial Vehicles– DODs Acquisition Efforts: 9 April 1997, 4.

[20] Ibid.

[21] Ibid.

[22] Ibid., 5.

[23] Ibid.

[24] Ibid.

[25] Ibid.

[26] Ibid.

[27] "Hunter's Struggle," *Armed Forces Journal International*, May 1997, 29.

[28] Senate, Fiscal Year 97 Defense Authorization, Focusing on Technology Base Programs: Testimony of Dr. Paul Kaminski, Undersecretary of Defense for Acquisition and Technology before the Armed Services Subcommittee on Acquisition and Technology of the Senate Committee on Armed Services, 20 March 1996.

[29] Ibid.

[30] Ibid.

[31] House, Tactical Unmanned Aerial Vehicles: Briefing to Subcommittee on Airland Forces Senate Armed Services Committee, 29 March 1996, 75.

[32] House, Unmanned Aerial Vehicles– DODs Acquisition Efforts: 9 April 1997, 5.

[33] Ibid., 6.

[34] Ibid.

[35] "Pilotless Progress: The Steady Rise of UAVs," *Janes Defence Weekly*, 17 September 1997, 15.

[36] Ibid.

[37] Gen Ronald R. Fogelman, "The Air Force Moves Out on Unmanned Aerial Vehicles," *Unmanned Systems*, Fall 1995, 43.

[38] "Pilotless Progress: The Steady Rise of UAVs," *Janes Defence Weekly* 17 September 1997, 15.

[39] House, Unmanned Aerial Vehicles– DODs Acquisition Efforts: 9 April 1997, 6.

[40] "USAF Predator for the Future," Air Combat Command UAV CONOPs, 1; on-line, Internet, available from http://www.acc.af.mil/do/dou/commit.htm.

[41] House, Unmanned Aerial Vehicles– DODs Acquisition Efforts: 9 April 1997

[42] Maj Thomas Wozniak, ACC/DOU, interviewed by author, 10 December 1997, 6.

[43] "USAF Predator for the Future," Air Combat Command UAV CONOPs, 1; on-line, Internet, available from http://www.acc.af.mil/do/dou/commit.htm.

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[44] Maj Mark Mol, "Advanced Concept Technology Development (ACTD): Are they Relevant in Today's Acquisition Environment?" Research Report no. 98-200. Maxwell AFB, AL: Air Command and Staff College, 1998.

[45] Gen Ronald R. Fogelman, "The Air Force Moves Out on Unmanned Aerial Vehicles," *Unmanned Systems*, Fall 1995, 43.

[46] Ibid.

Chapter 3

New Found USAF UAV Interest

Despite the slow spool-up UAVs demonstrated with the Aquila, Pioneer, Medium Range, Hunter, and Predator UAV systems, the mid-1990s brought with it new found USAF interest in UAVs—a departure from USAF's prior "hands off" UAV course. This chapter first establishes that senior Air Force leadership arrived at an accord accepting UAVs as a viable solution to meet mission needs. Next, the chapter suggests an impetus for the USAF leadership accord was the threat of mission loss to other military services aggressively pushing for further UAV developments as well as expansion of UAVs to other mission areas. The USAF UAV acceptance as well as an underlying reason precipitating it, in turn, provide the foundation for an aggressive USAF UAV course over-correction addressed in the next chapter.

USAF Leadership UAV Accord

In 1995, General Ronald R. Fogelman, then Air Force Chief of Staff, left little room for interpretation of his opinion on UAVs. Fogelman wrote, "the Air Force has come to realize the enormous potential of UAVs, and is eager to capitalize on it."[1] Fogelman's statement certainly demonstrates his acceptance of UAVs and also indicates a leader ready to exploit UAV technology. An *Unmanned Systems* article in mid-1996 further emphasized Fogelman's position on UAVs. The article stated "The Air Force, led by its

Chief of Staff General Ronald R. Fogelman, has strongly endorsed the use of UAVs. As evidence of this, the Air Force has sought and been assigned the program management responsibility for DOD's long endurance, high altitude Dark Star and Global Hawk UAV programs."[2] Further emphasizing his desired direction with UAVs for the USAF, in 1996 General Fogelman stated, "The bottom line is that on my watch, the Air Force will embrace UAVs and work to fully exploit their potential."[3] While these statements demonstrate General Fogelman's avid support and desired direction for UAVs, CORONA Fall 1996 was General Fogelman's forum to put the issue of UAVs before his senior officers.[4]

Though not all USAF senior officers attending CORONA Fall 96 necessarily agreed with General Fogelman's UAV advocacy, they did arrive at a consensus that the USAF needed to increase its "strategic investment stream" in this area.[5] Supporting a general consensus on major USAF issues at CORONA is the 1997 Air Force Long-Range Plan summary which explains that at CORONA Fall 1996 "the Air Force's most senior leaders stepped up to the issues of mounting global challenges and rapid technological change to develop a vision for the future."[6] As a result of CORONA Fall 1996 *Global Engagement: A Vision for the 21st Century Air Force* was released and charted a strategic course for the Air Force including an aggressive path for implementation of UAVs over the full range of combat missions. According to *Global Engagement*,

> The highest payoff applications in the near-term are Intelligence, Surveillance, Reconnaissance (ISR), and communications. A dedicated Air Force UAV squadron will focus on operating the Predator medium-range surveillance UAV, which also will serve as a testbed for developing concepts for operating high altitude, long endurance UAVs. In the mid-term, the Air Force expects that suppression-of-enemy-air-defense (SEAD) missions may be conducted from UAVs, while the migration of

> additional missions to UAVs will depend upon technology maturation, affordability and the evolution to other forms of warfare.[7]

Global Engagement's vision championed by General Fogelman and then Secretary of the Air Force Shiela Widnall provides the evidence of new found USAF interest in UAVs. However, as outlined in Chapter 2, UAV performance up to and including Predator did not represent a quantum leap in UAV capabilities. Why the sudden interest in UAVs by Air Force leadership?

UAVs—Threat to USAF Missions?

The cancelled Aquila, Hunter, and Medium Range UAV programs did not provide successful demonstration of UAV technology to accomplish assigned missions reliably and cost effectively. As the previous chapter shows, Pioneer and Predator operational performance did not represent a leap in technology and capability worthy of instigating an embrace of UAVs by the Air Force. If technical achievement did not warrant a USAF UAV embrace, perhaps the threat of sister service expansion into traditional USAF mission areas—and resultant USAF alarm—might explain subsequent USAF interest in UAV development.

As outlined in Chapter 2, the Army, Marine Corps, and Navy seemed generally pleased with Pioneer's Gulf War performance. Though Pioneer's technology left much to be desired, the services developed an appreciation for the potential of UAV technology and were interested in furthering it.[8] For example the Marine Corps, primary users of Pioneer during the Gulf War, led a mid-1990s charge to acquire a follow-on tactical UAV, Outrider, as a replacement for its aging Pioneer systems.[9] With a maximum range of 200km, Outrider, was rapidly encroaching on traditional Air Force battle space.[10] The

Army was also anxious to capitalize on the advantages tactical ISR UAVs offered the battlefield commander.[11] Meanwhile, the Marine Corps was also looking to expand UAVs to other mission areas. In 1996 General Krulak wrote , "the Marine Corps is actively looking for additional applications (beyond ISR) of UAV technology." In fact, sister service expansion was a "major concern" at CORONA Fall 96.[12] According to Colonel Jim Engle, Chief, Future Concept Development within the USAF Strategic Planning Directorate, General Fogelman used this as one of his concerns to "convince the rest of the four-stars that we (USAF) need to get on board" with UAVs.[13] Subsequently, it seems the Air Force saw the "UAV train" leaving the station and decided it had better get on or be left behind.

It is interesting to note a remarkable similarity between explanations for 1990s USAF UAV acceptance and a similar 1950s USAF acceptance of Inter-Continental Ballistic Missiles. Jeffrey Record, in *The Future of the Air Force* claims the 1950s USAF demonstrated interest in ICBMs when it perceived the possibility of mission loss to sister services.[14] Record explains USAF restricted its "interest in the ICBM largely to situations in which it perceived a threat…from a sister service to acquire them."[15] Records statement is highlighted not to equate ICBMs to UAVs but simply to note, from a historical perspective, the Air Force seems to have been "down this road before."

Returning to the mid-1990s, USAF began to demonstrate sudden interest in UAVs and, judging by its strategic UAV vision outlined in *Global Engagement*, decided it had much lost ground to make up from its previous "hands off" UAV approach. In making up for lost ground—in the authors opinion—the Air Force made a UAV course over-correction. The over-correction is embodied in four UAV end states drawn from the

Global Engagement strategic vision as well as heavy reliance on two unproven HAE UAV systems, Global Hawk and Dark Star. Both the end states and the HAE UAV systems are discussed in the next chapter.

Notes

[1] Gen Ronald R. Fogelman, "The Air Force Moves Out on Unmanned Aerial Vehicles", *Unmanned Systems*, Fall 1995, 43.

[2] Gerald Green, "Pentagon Envisions Unmanned Combat Aircraft While Current UAV Programs Advance", *Unmanned Systems*, Summer 1996, 40.

[3] "USAF Predator for the Future," Air Combat Command UAV CONOPs, 1; on-line, Internet, available from http://www.acc.af.mil/do/dou/commit.htm.

[4] Col Jim Engle, Email. Subject: UAV Research, 9 March 1998.

[5] Ibid.

[6] 1997 Air Force Long-Range Plan: Summary." On-line. Internet, 22 Mar 98. Available from http://www.xp.hq.af.mil/xpx/xpxc/m-cindu.htm.

[7] Department of the Air Force, *Global Engagement: A Vision for the 21st Century Air Force*, 1997, 14.

[8] Gen Charles C. Krulak, "Riding the Dragon into the 21st Century," *Unmanned Systems*, Summer 1996, 11.

[9] Ibid., 12.

[10] Lt Col Ron Gregory, US Army Training and Doctrine Center, Ft Monroe, VA., interviewed by author 10 Dec 97.

[11] Gregory.

[12] Col Jim Engle, Email. Subject: UAV Research, 9 March 1998.

[13] Ibid.

[14] Quoted in Carl Builder, *The Icarus Syndrome* (New Brunswick, NJ: Transaction Publishers, 1994), 171.

[15] Ibid.

Chapter 4

USAF UAV Course Over-Correction

Four USAF UAV end states, or goals, and two unproven HAE UAV systems represented the Air Force's new found interest in UAVs and an adjustment from its previous USAF "hands off" UAV course. This chapter first introduces the end states which simultaneously provide specific mission areas for UAV application as well as chart an aggressive timeline for their implementation. Next, the chapter describes the means to the end states, Global Hawk and Dark Star UAVs. The chapter then illustrates that Global Hawk and Dark Star's combined ACTD demonstrates a pattern of continued programmatic setbacks and cost overruns impacting not only USAF willingness to fund the programs but also the ability to achieve end state timelines. The chapter finally suggests the Air Force, in its zeal to protect USAF mission areas, over-corrected from its previous "hands off" UAV path and charted a course incongruent with the evolution of UAV technology to date.

Four USAF UAV End States

The four USAF UAV end states, still current today, flow directly from senior Air Force leadership's strategic vision for UAVs outlined in *Global Engagement* and progress from non-lethal to lethal uses of UAVs. The four end states as well as the timelines associated with end state completion are summarized as follows:

1. Deploy a HAE UAV to replace current Air Force manned ISR systems to include the U-2 and RC-135. (Goal 2002 – 2005) [1]
2. Deploy a HAE UAV communications relay system, Airborne Communications Node (ACN), that augments or replaces manned platforms such as Airborne Command, Control, and Communications (ABCCC) platforms. (Goal 2002-2008)[2]
3. Deploy a capability to perform both lethal and non-lethal Suppression of Enemy Defense (SEAD) missions. (Goal 2002-2009)[3]
4. Become the premier operator and developer of UAVs by capitalizing on available technologies and aggressively exploiting commercial technologies for follow-on systems.(No specific timeline)[4]

Providing the means to the end states, a HAE UAV ACTD with Global Hawk and Dark Star began to intensify in 1996.[5]

HAE UAV Attributes

Both Global Hawk and Dark Star are designed to complement national reconnaissance assets (space and manned) providing high resolution imagery from low to medium risk operating areas.[6] The systems are designed to operate at high altitudes and slow airspeeds allowing the capability to remain on station for extended time periods. ISR payloads include electro-optical, infrared and synthetic aperture radar sensors permitting the capability to disseminate imagery to the theater CINC.[7] Furthermore, Dark Star offers this capability in a low observable air vehicle for medium threat mission areas. In support of USAF End State 2, a communications payload for Global Hawk is being designed to enable enhanced communications capabilities. In addition, both systems provide a testbed for development of SEAD technologies in support of End State 3.[8] In "theory" both systems should provide a variety of theater-wide capabilities; however, in "practice" both systems have exhibited difficulties.

HAE UAV ACTD Setbacks

Global Hawk's progress to date has been characterized by schedule slips and cost overruns. Originally scheduled for its first flight in February of 1997, Global Hawk's maiden flight was slipped to late fall 1997.[9] Slipping further, the air vehicle subsequently flew its maiden flight in February 1998.[10] In addition to schedule slips, Global Hawk has not been immune to cost overruns. Lack of system performance, due in part to contractor oversold capabilities, required an additional $110 million dollars to be added to the program in an attempt to keep it on track.[11] According to Mr Tom Hydock, formerly with DARO, contractors at times can paint a "pretty picture" to sell a system but disappoint when performance lacks.[12] Meanwhile DOD is left to make the decision to ante up funds to keep the program alive or cut its losses and run. However, in defense of Global Hawk oversold systems are neither new nor unique to UAVs.[13] Nevertheless, the bottom line remains the first flight of Global Hawk was slipped one year and the program, so far, has spent $110 million more than anticipated.

Like Global Hawk, Dark Star's program schedule has experienced setbacks. Though Dark Star's first flight went as scheduled in March 1996, the second flight a month later ended in a crash on take off. Software problems leading to errant flight control inputs on takeoff were found to be the cause of the crash.[14] The second flight was rescheduled for October 1997, a year and a half slip in the schedule. However, as of early 1998 Dark Star has yet to fly again.

Impact of HAE UAV Setbacks

Global Hawk and Dark Star setbacks seem to have chipped away at USAF confidence in the evolution of UAV technology following its acceptance of UAVs. This

is apparent in both a USAF unwillingness to ante up funds in support of the end states as well as recent recommendations to slip end state completions in light of HAE UAV miscues.[15]

Across the Fiscal Year (FY) 00 to FY 05 Future Years Defense Plan (FYDP) only one tenth of the $3.5 billion required to maintain the current course for UAV End States 1 through 3 is currently funded.[16] In addition, the Program Objective Memorandum (POM) for FY 00 is currently under review; most affected during this cycle is End State 1—developing a HAE ISR UAV.[17] With the HAE UAV ACTD and its associated funding ending in December of 1999, HAE UAV operational infrastructure costs associated with meeting End State 1 shift to USAF and fall in the current POM cycle.[18] However, the End State 1 office of primary responsibility, Air Combat Command, is reluctant to ante up the funds in light of HAE UAV progress.[19] Lack of funding driven largely by poor HAE UAV performance, in turn, has affected USAFs ability to achieve the end state timelines.

In a recent HQ USAF/XO briefing, the impact of funding shortfalls and HAE UAV schedule slips produced recommendations to slip the original timelines for End States 1 through 3.[20] The adjustments are summarized below.

End State 1	Extend beginning ISR UAV deployment from 2002-2005 to 2005+.[21]
End State 2	Set earliest ACN deployment to not before 2005 based on slip in End State 1.[22]
End State 3	Extend full accomplishment of End State 3 from 2009 to 2016.[23]

Recent USAF lack of end state funding commitment as well as slips in end state timelines, in the authors opinion, imply the UAV course selected by the USAF following its mid-1990s acceptance of UAVs was an over-correction from its previous “hands off”

path. While protection of USAF missions from sister services provides an explanation for the over-correction, a mistake the USAF made was not in its decision to accept UAVs to fulfill mission needs, but that the USAF based its new UAV course on less-than-proven technology.

UAV Course Based on Less-than-Proven UAV Technology

Previous UAV technology has not demonstrated the capability to support an aggressive UAV course adjustment in the mid-1990s. UAV program development preceding the genesis of the mid-1990s USAF interest in UAVs—Aquila, Pioneer, Hunter, Medium Range, and Predator—demonstrated a slow evolution of UAV technology and arguably limited capability. At the risk of being accused of "Monday morning quarterbacking", the author contends Global Hawk and Dark Star program setbacks, after the course adjustment, serve to reinforce this point. Further strengthening the argument USAF based its current UAV course on less-than-proven technology is the Senate Appropriations Committee.

In July 1997, discouraged in part by the results of Global Hawk and Dark Star ACTDs, the committee threatened a one year moratorium on beginning new UAV programs or ACTDs.[24] They went on to say "the committee is unaware of any other major DOD program where current, proven systems that are used on a daily basis throughout the world (U-2, RC-135, and SR-71) have been consistently sacrificed for almost 20 years of yet-to-be-realized technology development (UAVs)."[25] DOD officials have also been less than impressed with the development of UAV technology.

Summing up eighteen years of sub-par DOD UAV development efforts before Congress in April, 1997 Louis Rodrigues, Director, Defense Acquisitions Issues,

National Security and International Affairs Division testified, "Since Aquila began in 1979, of eight UAV programs, three have been terminated (Aquila, Hunter, Medium Range), three remain in development (Outrider, Global Hawk, Dark Star), and one is now transitioning to low rate production (Predator). Only one of the eight, Pioneer, has been fielded as an operational system. We estimate DOD has spent more than $2 billion for development and/or procurement on these eight UAV programs over the past 18 years."[26]

The previously stated unwillingness of the Air Force to commit to funding UAV end states in support of its mid-1990s UAV course adjustment indicate, in the authors opinion, even the USAF is a bit uncomfortable with not only its current direction with UAVs but also UAV technology. Consequently, if the evolution of UAV technology does not support the current USAF UAV course, why not adjust the course commensurate with demonstrated technology evolution? In other words, the Air Force needs a moderate UAV course founded on proven technology and conservative investment.

Notes

[1] Briefing, HQ USAF/XO, subject: UAV End States, 1997.
[2] Ibid.
[3] Ibid.
[4] Ibid.
[5] House, Unmanned Aerial Vehicles—DODs Acquisition Efforts: Testimony of Mr Louis J Rodrigues, Director, Defense Acquisition Issues, National Security and International Affairs Division before Subcommittee on Research and Development and Military Procurement of the Committee on National Security, 9 April 1997, 6.
[6] Ibid.
[7] Ibid.
[8] HQ USAF/XO Briefing, 1997.
[9] House, Unmanned Aerial Vehicles—DODs Acquisition Efforts: 9 April 1997, 6.
[10] "Global Hawk Begins Flight Test Program." *Aviation Week and Space Technology*, 9 March 1998, 22.
[11] Maj Jeff Needham, HQ USAF/XORBR, interviewed by author, 9 December 1997.

Notes

[12] Tom Hydock, Defense Airborne Reconnaissance Office, interviewed by author, 9 December 1997.

[13] Needham.

[14] House, Unmanned Aerial Vehicles—DODs Acquisition Efforts: 9 April 1997, 6..

[15] HQ USAF/XO briefing, 1997.

[16]Ibid.

[17] Needham.

[18] Ibid.

[19] Ibid.

[20] HQ USAF/XO briefing, 1997.

[21] Ibid

[22] Ibid

[23] Ibid

[24] "Appropriators: No New UAV Programs Until DOD Proves Strategy." *Inside the Air Force*, 11 July 1997, 5.

[25] Ibid.

[26] House, Unmanned Aerial Vehicles—DODs Acquisition Efforts: 9 April 1997, 3.

Chapter 5

A Moderate Course for UAV Development

In a speech titled "The Air Force at a Crossroads" given before the Air Force Association National Symposium in November 1997, General Estes, CINC SPACECOM, commented, "Today as we approach yet another crossroad in our 50 year legacy, we as an Air Force…need to throttle back just a little bit and consider the alternate routes to our future destination. We must be prepared to make a turn if we deem, in fact, that a turn is the right thing to do."[1]

While General Estes' comments were made in the context of space, the same concept holds true for future Air Force endeavors—including UAVs. Undoubtedly, the Air Force is at a crossroads. Shrinking defense dollars, rapidly advancing technology in all areas, and varying means to accomplish the same mission indicate the Air Force has, and will continue to have, difficult decisions to make. A future course for UAV development is one of those decisions.

This chapter proposes a moderate UAV course for the future—one based on proven technology and conservative investment. Enabling this moderate UAV course is a "wait and see" approach to the ongoing HAE UAV ACTD. As previously outlined, USAF is currently deliberating whether or not to commit funds towards infrastructure costs associated with moving from HAE UAV ACTD completion in December 1999 to

subsequent production and operational use of HAE UAVs in support of UAV End State 1.[2] The current point of contention over UAV funding—driven home in the previous chapter—is the unproven technology associated with HAE UAVs. A "wait and see" approach enables the USAF to allow UAV technology to prove itself without "mortgaging the farm" doing it.

"Wait and See"

As General Estes stated, "the Air Force is at a crossroads."[3] Tough funding decisions are in the Air Force's immediate future and taking the step to begin to commit significant funds towards HAE UAV operational infrastructure (approximately $80 million this POM cycle) upon ACTD completion is one of those decisions.[4] However, is this decision all or nothing? Must the Air Force decide now, with yet to be proven HAE UAV systems, to either begin to leverage substantial capital towards bringing HAE UAVs on line operationally or cancel the HAE UAV program?

There is a middle ground for USAF HAE UAV funding and it represents a moderate UAV course based on proven UAV technology. The middle ground to USAF UAV funding initially employs a "wait and see" approach to the HAE UAV ACTD. In other words, USAF should not take the step to begin to commit significant infrastructure funds towards HAE UAVs—until the technology is proven capable and reliable. However, USAF should take the step now to set aside funds for the capability to sustain the ACTD assets, associated personnel, etc. at a minimal operational capability once the ACTD is completed in December 1999. This moderate course for USAF UAV funding results in two possible scenarios.

First, the HAE UAV ACTD demonstrates significant difficulties and is unable to complete its ACTD successfully. In this scenario, USAF commits minimal funding—at minimal expense to other systems—associated with simply maintaining the assets upon ACTD completion, but avoids a much bigger commitment associated with full funding of HAE UAV infrastructure costs.

In the second scenario, Global Hawk and Dark Star demonstrate the capability to perform required missions and the HAE UAV ACTD is successfully completed. This scenario puts the USAF in the position of making up for lost time as the ACTD assets continue at a minimal operational capability waiting for required infrastructure (squadron buildings, personnel, etc.) to come on line.

However, the risk of committing substantial amounts of money to UAVs – at the expense of other systems—exceeds the operational time lost waiting on infrastructure buildup. Based on the sub-par track record of previous UAV systems and the slow start for HAE UAVs—shown in a previous chapter—avoiding the risk of committing USAF money on unproven technology is worth the wait for HAE UAVs to spin up to full operational capability upon completion of a successful ACTD. Furthermore, assuming the ACTD is a success, upon ACTD completion the remaining assets could transfer to UAV Battle Lab testing/minimal operational capability while current manned assets continue to perform the ISR mission awaiting for HAE UAVs to come on line.[5]

This moderate UAV course proposal enabled by a "wait and see" approach with the HAE UAV ACTD provides for proven UAV technology and conservative investment in the near term. While the author believes the general direction for USAF UAV development embodied in the four current end states (ISR, CAN, and SEAD) is valid,

future USAF UAV endeavors must also continue to be based on proven technology. Regarding future USAF UAV development, many questions still remain. For example, while ISR, ACN, and SEAD provide direction for UAV emphasis in the near to mid-term what other missions might UAVs perform? What criteria should be used to identify these missions? What criteria should be used to determine whether spaced based, manned, or unmanned systems perform identified missions? While these questions demonstrate there is still much to consider with UAVs, a moderate USAF UAV course enabled by proven technology and wise investment is a step in the right direction towards beginning to provide some answers.

Notes

[1] Gen Howell Estes, CINC SPACECOM, address to the Air Force Association National Symposium, Los Angeles, CA, 14 November 1997.

[2] "1997 United States Air Force Issues Book," n.p. On-line. Internet, 10 December 97. Available from http://web.fie.com/fedix/vista.html.

[3] Estes.

[4] Briefing, HQ USAF/XO, subject: UAV End States, 1997.

[5] Maj Jim Lovell, student, Air Command and Staff College, formerly worked Reconnaissance Acquisitions at Wright Patterson AFB, OH, interviewed by author 15 Mar 98.

Chapter 6

Conclusions

The purpose of this paper was to provide a logical argument supporting a moderate USAF UAV course based on proven technology and conservative investment

In support of this argument, the paper first provided a chronology of five UAV programs representing an abridgement of DOD tactical UAV development and acquisition efforts during the 1980s and early 1990s. The purpose of the chronology was two-fold. First, the UAV chronology allowed the reader to develop sufficient perspective of the sub-par evolution of UAV capabilities, technology, and development. Second, the chronology depicted a conspicuous lack of USAF involvement in most of these tactical UAV programs indicating a lack of early UAV interest on the part of the Air Force. Admitted reluctance by senior USAF leadership to accept UAVs to meet mission needs provided concrete evidence supporting a USAF "hands off" approach to UAVs during the 1980s and early 1990s.

Next, despite the sub-par performance of previous UAV systems, the paper evidenced a mid-1990s new found interest in UAVs by the Air Force. An explanation for the new USAF interest in UAVs was senior USAF leadership concern over mission loss to other services advocating the use and further development of UAVs. Subsequently, led by its Chief of Staff, USAF senior leadership developed a consensus to accept UAVs

as a viable solution to mission needs. The consensus was embodied in *Global Engagement: A Vision for the 21st Century Air Force* which outlined an aggressive strategic vision for UAV development.

The subsequent USAF UAV course charted following its mid-1990s acceptance of UAVs represented a significant departure from the previous USAF "hands off" path. Furthermore, the new course was founded on the less-than-proven UAV technology evidenced in previous tactical UAV programs. Supporting this contention, subsequent HAE UAV setbacks soon impacted USAF UAV end state timelines and funding—indicating the new USAF UAV course in fact represented a course over-correction founded on less-than-proven UAV technology.

Therefore, a moderate course for future UAV development is required—one based on proven UAV technology and conservative investment. Enabling this moderate course is a "wait and see" approach to the ongoing HAE UAV ACTD. This approach commits minimal USAF funding towards infrastructure costs associated with the operational use of HAE UAVs pending proof of requisite UAV technology during the ACTD. This approach accepts the risk of lost operational HAE UAV capability following ACTD completion in favor of a moderate UAV funding commitment during the current POM cycle.

This paper recommends USAF adopt the moderate UAV course.

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